SPIXIANA	**23**	2	121–128	München, 01. Juli 2000	ISSN 0341-8391

Chironomids of small Alpine water bodies (springs, spring brooks, pools, small lakes) of the northern Calcareous Alps

(Insecta, Diptera, Chironomidae)

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Orendt, C. (2000): Chironomids of small Alpine water bodies (springs, spring brooks, pools, small lakes) of the northern Calcareous Alps. – In: Baehr, M. & M. Spies (eds): Contributions to chironomid research in memory of Dr. Friedrich Reiss. – Spixiana **23/2:** 121-128.

30 small Alpine water bodies (springs, spring brooks, pools, small lakes) of the northern Calcareous Alps (Berchtesgaden National Park, Germany, and adjacent regions in Austria) were surveyed for their chironomid communities in 1997 and 1998. Mainly, pupal exuviae were sampled. 94 taxa are recorded and listed. Three are new for Germany (*Diamesa wuelkeri* Serra-Tosio, *Corynoneura arctica* Kieffer, *Parakiefferiella fennica* Tuiskunen), five for Bavaria (the former, *Heterotrissocladius grimshawi* (Edwards), and *Limnophes asquamatus* Andersen), and one for Austria (*Chironomus nuditarsis* Keyl). No statistically significant correlations could be found between the occurrence of any taxon and altitude (m a.s.l.). This may be due to the small data set. 71 % of all taxa recorded could be determined on species level. Taxonomic diversity ranged from 10 (a lake) to 0 (hygropetric habitats). Compared to some earlier chironomid studies from the Calcareous Alps, the present survey achieved a higher proportion of determinations to species level. It is concluded that this is an effect of sampling pupal exuviae rather than larvae.

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Introduction

This paper is dedicated to F. Reiss. Some years ago he encouraged me to collect in the Alpine region. He was convinced that, if there is still anything faunistically interesting left to discover concerning the chironomids in central Europe, it will be found in the Alps. Remembering this I was happy to join a project in 1997 and 1998 surveying the macroinvertebrate and algal communities of springs in Berchtesgaden National Park. For chironomids, only few investigations on this small ecosystem are published (e.g. Crema et al. 1996, Thienemann 1936, 1942, Weigand & Tockner 1996). Moreover, as those were based on larval material, the taxonomic resolution is not as high as possible when using pupal exuviae or adults. Therefore, the available knowledge on chironomid communities in Alpine habitats is relatively meagre. On the other hand, new species were recorded or described in all investigations. Following that, further studies are urgently needed. In the Berchtesgaden project mentioned, chironomids were collected in springs as well as in brooks, meltwater pools and small lakes. Nearly all water bodies are situated higher than 1000 m a.s.l. The paper presented follows two aims: (1) to survey the chironomid communities of the various habitats by collecting mainly pupal exuviae in order to achieve

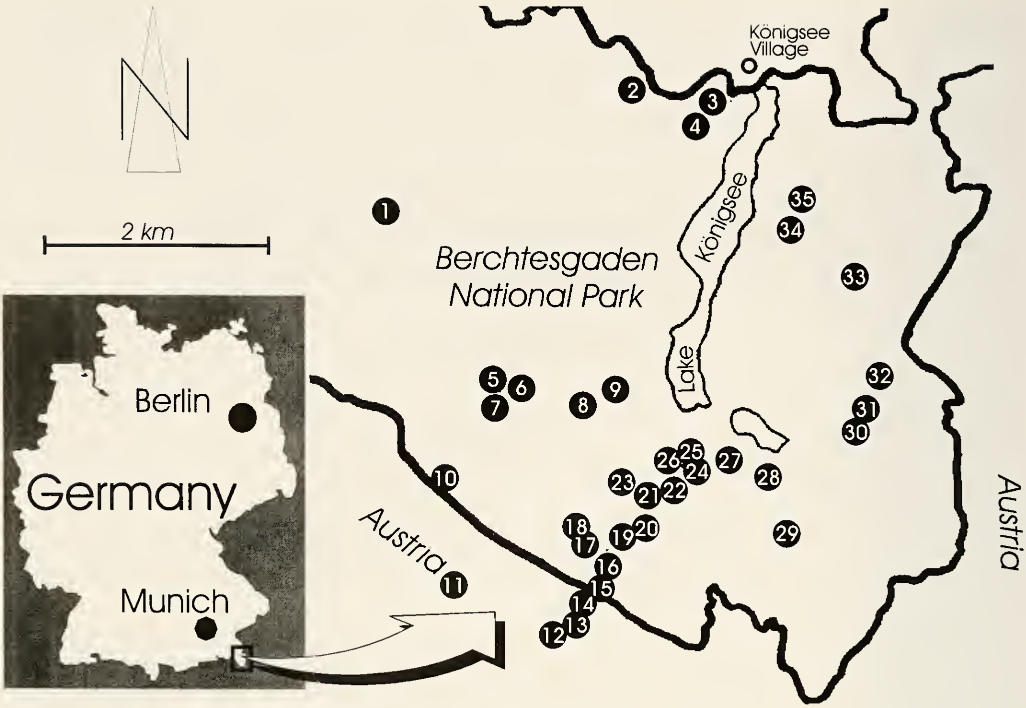


Fig. 1. Locations of sample sites (numbered as in tab. 1).

as many species-level identifications as possible, and (2) to compare the results with earlier studies sampling mainly larvae, and evaluate the methods used.

Sample sites

Four of the waters bodies investigated are situated in Austria, but the great majority of them are in Berchtesgaden National Park in the northern Calcareous Alps, around Lake Königsee (Upper Bavaria, Germany), between the Watzmann, Steinernes Meer, and Hagen mountains (Fig. 1). The rocks are often karstic and derive almost exclusively from marine sediments, mainly from the Triassic period. The area is characterized by steep slopes, plateaus and valleys. The vegetation is dominated by woods which decrease upward of about 2000 m a.s.l. Among the 35 sites on 30 waters studied, there are springs (rheocrenes, rheohelocrenes, hygropetric zones), spring brooks, meltwater pools and small lakes, located between 960 m and 2150 m a.s.l. An overview of their characteristics is given in Tab. 1.

Material and methods

As a survey of high taxonomic resolution was one of the main goals of the study, I sampled mainly the surface drift for pupal exuviae which can be determined at species level in most cases.

Sampling was performed with a hand net ("Thienemann-Kesher", mesh size 250 μm). The net was pulled across the surface of the water for 15 to 20 min at each sample site, in running waters in a certain stretch, in pools and small lakes in the littoral zone. As far as possible without damaging the habitat, this technique was used also in springs. In very small springs or hygropetric habitats, the chironomids were picked up with tweezers. Using these methods, I obtained pupal exuviae, larvae and, in small numbers, adults.

The sampling periods were from 25 to 30 June 1997 and from 16 to 19 July 1998, chosen to find all waters free of snow cover.

Tab. 1. Sample sites and their characteristics; . = no measurement; *) refer to Fig. 1.

site nr.*)	site name	m a.s.l.	water type	date of sampling	sampled material	date of measurements	dis charge [l/s]	temperature [°C]	conduct. [µS/cm]	pH	oxygen [mg/l]
1	Mittergraben (Wimbachtal)	1300	brook	19.07.98	drift	.	.	.	.	.	.
2	Schapbach-Quelle	1120	rheocrene	25.06.97	surface drift	.	.	.	.	.	.
3	Sommerbichl-Weide (spring)	1170	rheocrene	26.06.97	surface drift	.	.	.	.	.	.
4	Herrenroint "F"	1280	spring brook	25.-26.06.97	drift	.	.	.	.	.	.
5	Graskopf (upper spring)	1840	rheocrene	18.07.98	drift	18.07.98	0,25	4,5	209	8,12	10,8
6	Rauhe Köpfe	1860	lake	18.07.98	drift	18.07.98	0,10	3,8	150	8,56	11,8
7	Graskopf (pool)	1810	meltwater pool	18.07.98	drift	18.07.98.	.	24,0	.	.	.
8	Saugasse	1200	hygropetric	16.07.98	benthos	.	.	.	.	.	.
9	Schrainbachquelle	960	rheocrene	30.06.97	surface drift	15.07.98	200,00	5,5	156	8,33	11,7
10	A spring NE of Ingolstädter Haus ("Hundstodscharte")	2040	rheocrene	18.07.98	drift	18.07.98	0,10	.	.	.	.
11	Steinernes Meer (Wegscheid/Weißbachscharte)	2150	hygropetric	17.07.98	benthos	17.07.98	0,01	4,9	126	8,33	10,0
12	Wunderquelle	2000	hygropetric and small spring pool	17.07.98	benthos	17.07.98	0,02	5,2	124	8,41	10,5
13	Steinernes Meer, a lake NE of Wunderquelle	2050	lake	17.07.98	drift	17.07.98	0,20	12,2	117	8,48	10,1
14	Steinernes Meer, pool SW of mark "1949"	1990	meltwater pool	17.07.98	drift	17.07.98	0,00	11,5	108	8,66	11,1
15	Stuhlgraben (100 m below trail, drift along a 50 m stretch)	1700	spring brook	16.07.98	drift	16.07.98	1,00	5,3	231	7,95	9,77
15	Stuhlgraben (200 m stretch below spring)	1800	spring brook	16.07.98	drift	16.07.98	0,4	3,8	270	7,885	10,36
16	Rennergraben	1660	spring brook	30.06.97	drift	16.07.98	2,50	4,9	290	7,61	9,1
17	Funtensee, near Teufelsmühle	1601	lake	16.07.98	drift	16.07.98	10,00	10,1	226	8,47	9,9
18	Funtensee, southern shore	1601	lake	30.06.97	drift	.	.	.	.	.	.
19	Feldalm (lower spring)	1760	rheocrene	16.07.98	drift	.	.	.	.	.	.
20	Feldalm (upper spring)	1780	rheocrene	16.07.98	drift	.	.	.	.	.	.
21	Grünsee-Alm, meltwater pool	1600	meltwater pool	29.06.97	drift	.	.	.	.	.	.
22	Grünsee-Alm, spring	1600	rheocrene	29.06.97	drift	16.07.98	15,00	2,9	158	8,23	11,2
23	Grünsee, SE shore	1474	lake	29.06.97	drift	.	.	.	.	.	.
24	Schwarzensee (around the spring region)	1560	lake	29.06.97	drift	.	.	.	.	.	.
25	Schwarzensee (near outlet)	1560	lake	29.06.97	drift	.	.	.	.	.	.
26	Schwarzensee (mud in the littoral)	1560	lake	29.06.97	benthos	.	.	.	.	.	.
27	Halsköpfl (moss, stone, mud)	1680	hygropetric	29.06.97	benthos	.	.	.	.	.	.
28	Hüttau	1500	meltwater pool	29.06.97	drift	.	.	.	.	.	.
29	Wasseralm	1416	spring brook	29.06.97	drift	.	.	.	.	.	.
30	Landtal (30 m downstream from spring)	1540	spring brook	27.06.97	drift	.	.	.	.	.	.
31	Landtal-Quelle	1540	rheocrene	29.06.97	drift	.	.	.	.	.	.
32	Mitterhüttenalm	1630	meltwater pool	29.06.97	drift	.	.	.	.	.	.
33	Abwärtsgraben	1450	spring brook	27.06.97	drift	.	.	.	.	.	.
34	Priesberg-Alm, below a cottage	1470	rheocrene	27.06.97	drift	.	.	.	.	.	.
35	Priesberger Moos (above "Branntweinbrennhütte")	1360	meltwater pool	27.06.97	drift	.	.	.	.	.	.

In selected water bodies, temperature, conductivity, oxygen, and pH were measured with field instruments of WTW. The measurements were performed by Harald Haseke and Elmar Pröll of Calcareous Alps National Park in Upper Austria, who joined the excursions in 1998.

Results

a. General

A total of 94 chironomid taxa were recorded (see Tab. 2): 7 Tanypodinae, 9 Diamesinae, 1 Prodiamesinae, 56 Orthocladiinae, 21 Chironominae (9 Chironomini, 12 Tanytarsini). Taxonomic diversity ranged from 10 (Lake Grünsee, site nr. 23) to 0 (hygropetric springs, sites nr. 8 and 11).

Compared to the lists of Samietz (1996, 1999), three species are documented from Germany for the first time (*Diamesa wuelkeri* Serra-Tosio, *Corynoneura arctica* Kieffer, and *Parakiefferiella fennica* Tuiskunen). Samietz (1996) listed *D. wuelkeri* as "possible or likely" in Germany, and regarded the record of *C. arctica* by Dettinger-Klemm (1994) as doubtful. The present investigation has now proved the presence of *C. arctica* in Germany. *P. fennica* Tuiskunen had been recorded only from northern Palaearctic lakes (Langton 1991) and the Iberian Peninsula (Soriano et al. 1997). In Bavaria, compared to Reiss & Reiff (1995), five species were recorded for the first time: the former three plus *Heterotrissocladius grimshawi* (Edwards) and *Limnophes asquamatus* Andersen. For Austria, comparing to Janecek & Contreras (1995), *Chironomus nuditarsis* Keyl is recorded for the first time.

A mathematical evaluation of the faunistic data did not lead to significant results. Taxonomic diversity did not correlate with altitude (m a.s.l.). A definite pattern of the distribution of species in the various waters could not be shown, as the numbers and abundances of the taxa were too low for statistical analysis.

However, some typical communities can be demonstrated with the species found.

- In the two **hygropetric habitats** investigated, only taxa from other dipteran families were found (*Thaumalea* spec., *Oxycera* spec., *Tipula* spec.), but no chironomids.
- In both **springs** (represented here by rheocrenes) and **spring brooks**, forms not strictly limited to spring areas (crenobiontic) were recorded. The communities were formed from cold-stenothermic, crenophilic (e.g. *Heleniella serratosioi, Diamesa wuelkeri, Metriocnemus eurynotus, Parakiefferiella fennica*), and epirhithral taxa. Additionally, members of *Limnophyes, Thienemanniella, Corynoneura* and *Eukiefferiella* were recorded regularly.
- In **small lakes**, species known from littoral zones of cold lakes were characteristic (e.g. *Tanytarsus sinuatus, Paratanytarsus* spp., *Corynoneura arctica, Cricotopus albiforceps, C. reversus*).
- In **meltwater pools** with moderate to heavy organic pollution, *Chironomus nuditarsis* and *C. cingulatus* were found regularly.

In Tab. 2, the occurrences and abundances of the taxa are given, sorted according to water body type.

b. Taxonomic resolution

The distribution of identifications among taxonomic precision levels was as follows:

taxonomic level	number	% of all taxa
defined species	57	
"cf."	4	71
between two species*	6	
sp. 1, spec. A, Pe 2a, b	8	
species group	2	26
genus ("spec.")	14	
lower than "sp." **	3	3

* e.g. *Eukiefferiella minor/fittkaui;* ** e.g. Orthocladiinae gen. spec.

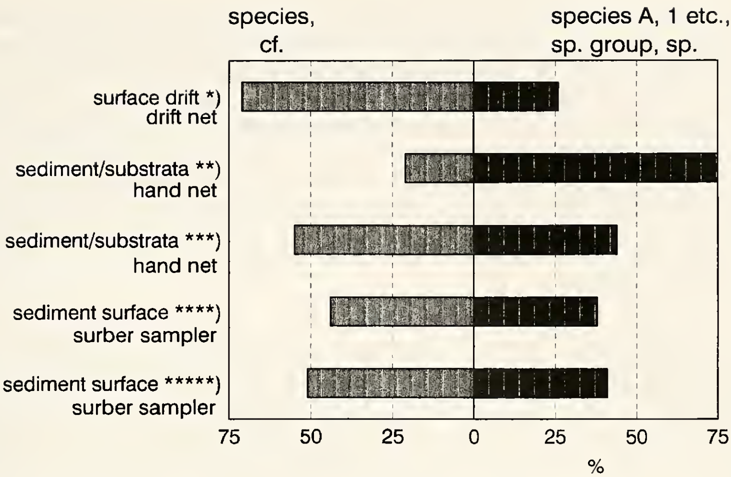


Fig. 2. Comparison of taxonomic determination levels achieved (in % of N = total number of taxa recorded) from different substrates, collecting methods, and studies. *) present study (N=94); **) Crema et al. (1996) (N=53 and 55, resp.); ***) Weigand & Tockner (1996) (N=63); ****) Janecek et al. (1991) (N=70); *****) Moog & Heinisch (1991) (N=150).

The different developmental stages were identified as follows:

taxonomic level	adults	pupal exuviae	larvae
defined species "cf." between two species*)	7	46	25
sp. 1, spec. A, Pe 2a, b species group genus ("spec.")	2	6	17
lower than "spec." **)	–	–	3

In summary, more than ⅔ of the taxa recorded could be determined to a level at least close to a defined species name. Most of these were based on pupal exuviae.

Comparing this distribution of taxonomic levels to earlier studies from Berchtesgaden National Park (Crema et al. 1996) and from the Austrian Calcareous Alps (Weigand & Tockner 1996, Janecek et al. 1991, Moog & Heinisch 1991), the present survey achieved the highest proportion of taxa determined to defined species (Fig. 2).

Discussion

The numbers of new records for Bavaria and Germany indicate the need for further study to gain a comprehensive overview of communities in Alpine habitats. Among the pupal exuviae collected there are forms of *Micropsectra* and *Smittia* that are probably new. F. Reiss had the opinion that it is very near to *M. seguyi* (*attenuata* group) from the Sierra Nevada. Sadly, his much too early death has made a description impossible at this time. From other invertebrate groups, new records and descriptions from Alpine spring ecosystems have also been reported recently (e.g. Hydracarina: Crema et al. 1996, Mollusca: Weigand & Tockner 1996). Thus, further new discoveries can be expected.

Most of the taxa recorded in this study can be found at lower altitudes as well. However, it is important to know up to what altitudes a species can occur (e.g. 2050 m for *Procladius choreus*, *Dicrotendipes modestus*, and *Tanytarsus sinuatus*, see tab. 2).

The lack of strictly crenobiontic species in the family Chironomidae has been noted by Lindegaard (1995) and can be confirmed from lowland springs (Orendt, in press). It seems also to be true for the

habitats studied here. This pattern was also found by Weigand & Tockner (1996) in macroinvertebrate communities of karstic springs in Austria, where the species reported were distributed in both springs and spring brooks. In contrast, for other invertebrate groups such as molluscs and water mites, the existence of certain species exclusively limited to the spring region is reported (e.g. Weigand & Tockner, l.c., Gerecke 1991). In the Berchtesgaden lakes and pools, the communities differed clearly

Tab. 2. List of chironomid taxa found in small water bodies of Berchtesgaden National Park (Germany) and adjacent regions, and the numbers of specimens collected (o = < 20; x = >20; no precise data available on sites nr. 13 and 17); *) developmental stage collected; **) hygropetric habitats, rocks with patches of algae and mosses; ***) site numbers refer to Fig. 1; ****) COP = *Cricotopus/Orthocladius/Paratrichocladius* group (taxa not discernible based on juvenile larval material).

water type		hygropetric			rheocrenes										spring brooks									meltwater pools						lakes							
site no. ***)		8	11	27	2	3	5	9	10	19	20	22	31	34	1	4	12	15	15	16	29	30	33	7	14	21	28	32	35	6	13	17	18	23	24	25	26
name of site		Saugasse*)	Steinernes Meer (Wegscheid)	Halsköpfl (moss, stone, mud)	Schappach	Sommerbichl-Weide (spring)	Graskopf (upper spring)	Schrainbach	Ingolstädter Haus	Feldalm (lower spring)	Feldalm (upper spring)	Grünsee-Alm, spring	Landtal-Quelle	Priesbergalm, below a cottage	Mittergraben (Wimbachtal)	Herrenroint F	Wunderquelle	Stuhlgraben (below the spring)	Stuhlgraben (below trail)	Rennergraben	Wasseralm	Landtal (spring brook)	Abwärtsgraben	Graskopf (pool)	Steinernes Meer, pool "1949"	Grünsee-Alm, pool	Hüttau	Mitterhüttenalm	Priesberger Moos	Rauhe Köpfe	Steinernes Meer, lake	Funtensee, near Teufelsmühle	Funtensee, southern shore	Grünsee, SE shore	Schwarzensee (spring region)	Schwarzensee (near outlet)	Schwarzensee (littoral)
m a.s.l.		1200	2150	1680	1120	1170	1840	960	2040	1760	1780	1600	1540	1470	1300	1280	2000	1800	1700	1660	1416	1540	1450	1810	1990	1600	1500	1630	1360	1860	2050	1601	1601	1474	1560	1560	1560
Tanypodinae	**)																																				
Macropelopia sp.	L			2		4								1																							
Macropelopia notata (Mg.)/*adaucta* K.	L						4			3																											
Procladius choreus (Mg.)	P																														o						
Psectrotanypus varius (Fab.)	P																												2								
Trissopelopia longimana (Staeger)	P					4																															
Trissopelopia sp.	L					9																															
Zavrelimyia barbatipes (Kieffer)	P																																1				
Diamesinae																																					
Diamesa insignipes K.	L											1																									
Diamesa starmachii Kow. & Kow.	L																																1				
Diamesa cf. *steinboecki* Goetgh.	L														1																						
Diamesa wuelkeri Serra-Tosio	P																						1														
Diamesa zernyi gr.	L																			1																	
Diamesa sp. 1	L																	1	1																		
Diamesa sp.	L										2				1																						
Pseudodiamesa branickii (Nowicki)	LP									2			8	1							15	3				1											
Pseudokiefferiella parva (Edw.)	L			3																																	
Prodiamesinae																																					
Prodiamesa olivacea (Mg.)	P													1																							
Orthocladiinae																																					
Brillia bifida (K.)	P											2																									
Bryophaenocladius muscicola (K.)	P																									1											
Chaetocladius sp. A	L									1																											
Chaetocladius piger gr.	L								1																												
Chaetocladius sp. *piger* (G.)/*dentiforceps*	L										11																										
COP****)	L								1				1								1																
Corynoneura arctica K.	P																														o	x		12			
Corynoneura lobata Edw.	PI				1							1	1																				30	1	1	18	
Corynoneura lobata Edw./*edwardsi* Br.	I																																			2	
Corynoneura sp.	L				3																	1	1														
Cricotopus (C.) albiforceps (K.)	P																																	2			
Cricotopus (C.) curtus Hirv.	L				1																																
Cricotopus (I.) cf. *laricomalis* Edw.	P																														x						
Cricotopus (I.) reversus Hirv.	P																																	1			
Cricotopus (I.) sylvestris (Fab.)	P																																1				
Cricotopus (I.) sp.	P																															1					
Cricotopus sp.	L																																	1			
Cricotopus/Orthocladius juv.	L																														x						
Eukiefferiella brevicalcar (K.)	LP				1										1						1					1											
Eukiefferiella coerulescens (K.)	P														2																						
Eukiefferiella gracei (Edw.)	L														1																						
Eukiefferiella cf. *gracei*	L							1													1																
Eukiefferiella lobifera Goetgh.	L							6											2		4																
Eukiefferiella minor (Edw.)/*fittkaui* Lehm.	LP							8								2			1		3																
Heleniella ornaticollis (Edw.)	L			2																																	
Heleniella serratosioi Ringe	P																	2	1				2														
Heterotrissocladius grimshawi (Edw.)	P						2																														
Heterotrissocladius marcidus (Walk.)	L									3				10																							

from those of the running waters. However, *Pseudodiamesa branickii* was found both in a spring and a pool fed by melting snow, obviously responding to cold temperature more than to higher flow velocities. *Paratanytarsus laccophilus* was collected in lakes, but also in a steep brook with stones and gravel. This is unusual, as the species was previously known only from standing waters (e.g. Fittkau & Reiss 1978, Langton 1991, Janecek & Contreras 1995).

Compared to the faunistic results from other Alpine water bodies (Crema et al. 1996, Weigand & Tockner 1996, Janecek et al. 1991, Moog & Heinisch 1991), the present survey showed both the highest number and proportion of taxa identified on species level. In contrast, the proportion of taxa deter-

Tab. 2. (continued).

water type		hygro-petric			rheocrenes										spring brooks									meltwater pools						lakes							
site no. ***)		8	11	27	2	3	5	9	10	19	20	22	31	34	1	4	12	15	15	16	29	30	33	7	14	21	28	32	35	6	13	17	18	23	24	25	26
name of site		Saugasse*)	Steinernes Meer (Wegscheid)	Halsköpfl (moss, stone, mud)	Schappach	Sommerbichl-Weide (spring)	Graskopf (upper spring)	Schrainbach	Ingolstädter Haus	Feldalm (lower spring)	Feldalm (upper spring)	Grünsee-Alm, spring	Landtal-Quelle	Priesbergalm, below a cottage	Mittergraben (Wimbachtal)	Herrenroint F	Wunderquelle	Stuhlgraben (below the spring)	Stuhlgraben (below trail)	Rennergraben	Wasseralm	Landtal (spring brook)	Abwärtsgraben	Graskopf (pool)	Steinernes Meer, pool "1949"	Grünsee-Alm, pool	Hüttau	Mitterhüttenalm	Priesberger Moos	Rauhe Köpfe	Steinernes Meer, lake	Funtensee, near Teufelsmühle	Funtensee, southern shore	Grünsee, SE shore	Schwarzensee (spring region)	Schwarzensee (near outlet)	Schwarzensee (littoral)
m a.s.l.		1200	2150	1680	1120	1170	1840	960	2040	1760	1780	1600	1540	1470	1300	1280	2000	1800	1700	1660	1416	1540	1450	1810	1990	1600	1500	1630	1360	1860	2050	1601	1601	1474	1560	1560	1560
Limnophyes asquamatus (And.)	I												1																							1	
Limnophyes edwardsi S th.	P																															2					
Limnophyes minimus (Mg.)	P																								1												
Limnophyes natalensis (K.)	I																													5							
Limnophyes pumilio (Holm.)	I													1																							
Limnophyes sp.	PI								5								4															2					
Metriocnemus eurynotus (Holm.)	L													1																							
Metriocnemus fuscipes (Mg.)	P																							1													
cf. *Orthocladius* sp.	L																9																				
Orthocladius (Eudactyl.) fuscimanus (K.)	P																							1													
Orthocladius (Eu.) frigidus (Z.)	L														2																						
Orthocladius (Eu.) luteipes Goetgh.	L												1																								
Orthocladius (Eu.) cf. *thienemanni* K.	L																	1																			
Parakiefferiella bathophila (K.)/*scandica* Br.	P																															x					
Parakiefferiella fennica Tuisk.	P																		3																		
Parametriocnemus stylatus (K.)	LP														2	3							2														
Parorthocladius nudipennis (K.)	P											17																									
Psectrocladius (Ps.) brehmi K.	P																																		1	5	
Psectrocladius (Ps.) sordidell. (Z.)/*ventricos.* K.	P																		1													x					
Psectrocladius (Ps.) schlienzi W lk.	P																																	2			
Pseudorthocladius filiformis (K.)	P																									1											
Rheocricotopus (Rh.) effusus (Walk.)	P																									1											
Smittia sp.	I											1						1						1						3							
Thienemanniella cf. sp. D	L						1											5																			
Thienemanniella Pe2b	L						1												15																		
Thienemanniella Pe2a	P																	4					1														
Tvetenia bavarica (Goetgh.)	P				1																																
Tvetenia sp.	L															1																					
Chironominae																																					
Chironomus cingulatus Mg.	P																										5	5	8								
Chironomus nuditarsis Keyl	P																								1		11		13			x					
Chironomus obtusidens Goetgh.	P																																	2			
Dicrotendipes lobiger (K.)	P																															x					
Dicrotendipes modestus (Say)	PI																							1							x						
Dicrotendipes sp.	L							1													1												1				
Einfeldia pagana (Mg.)	P																															1					
Endochironomus (Endot.) Pe1	P																												1								
Micropsectra pharetrophora Fitt.& Reiss	P			3								2																									
Micropsectra fusca (Mg.)	P						1																														
Micropsectra cf. *junci* (Mg.)	I						1																														
Micropsectra cf. Pe4	P																	1																			
Micropsectra sp.	L																				5																
Paratanytarsus austriacus (K.)	P																															x	16	5		1	
Paratanytarsus laccophilus (Edw.)	P																		1												x	x					
Paratanytarsus penicillatus (Goetgh.)	P																																	6	1	7	1
Paratanytarsus sp.	L																																				
Polypedilum sp.	L					1								1																							1
Tanytarsus niger And.	P																																	6	1	5	
Tanytarsus sinuatus Goetgh.	P																							4	x						o						
Tanytarsus sp.	L				1				2																												

mined as "spec.", "spec. group", "agg.", "spec. A, B ..." or "spec. 1, 2 ..." is higher in all the studies mentioned. In the work of Crema et al. (1996), this type of taxa is dominating. The present relative improvement is, of course, not a result of a better sampling strategy than was used by my esteemed collegues, but rather a consequence of including pupal exuviae.

18 out of 38 taxa (47 %) determined from larval material could be identified to species level. This means that 20 % of all chironomid taxa recorded could be based on larvae. This proportion is too low to get a comprehensive overview of the communities. The situation can be improved by collecting pupal exuviae, which provides us with both a sufficient number of specimens and a higher taxonomic determination level, because identification of species from pupal exuviae is further developed than for larvae. Consequently, for further investigations I recommend to include the collection of pupal exuviae.

Acknowledgements

The project was sponsored by Berchtesgaden National Park. I wish to thank the project leaders R. Gerecke and H. Franz for the organisation, and all participants of the excursions for their excellent company and competent discussions. Thanks also to Martin Spies who revised the manuscript's English language.

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